

**WHAT IS CLAIMED IS:**

1                   1. A method for choosing an image from a plurality of three-dimensional models  
2 which is most similar to an input image; the method comprising the steps of:

3                   (a) providing a database of the plurality of three-dimensional models;

4                   (b) providing an input image;

5                   (c) positioning each three-dimensional model relative to the input image;

6                   (d) for each three-dimensional model, determining a rendered image that is most  
7 similar to the input image by:

8                   (i) computing a linear subspace that describes an approximation to the set  
9 of all possible rendered images that each three-dimensional model can produce under all possible  
10 lighting conditions where each point in the linear subspace represents a possible image; and

11                   (ii) finding the point on the linear subspace that is closest to the input  
12 image;

13                   (e) computing a measure of similarity between the input image and each rendered  
14 image; and

15                   (f) selecting the three-dimensional model corresponding to the rendered image  
16 whose measure of similarity is most similar to the input image.

1                   2. The method of claim 1, wherein step (a) comprises building each three-  
2 dimensional model from a series of images taken under predetermined lighting conditions.

1                   3. The method of claim 1, wherein step (a) comprises assigning a location to each  
2 point on the surface of each three-dimensional model and at least one corresponding identifier  
3 which identifies the fraction of light that is reflected at each point.

1                   4. The method of claim 3, wherein the at least one corresponding identifier  
2 comprises three albedos, one for each of how much red, blue, and green light is reflected.

1                   5. The method of claim 1, wherein step (b) comprises providing a two-  
2 dimensional input image.

1                   6. The method of claim 1, wherein step (c) comprises aligning predetermined  
2 points on the three-dimensional model and the input image.

1                   7. The method of claim 1, wherein step (d) is repeated for each of a red, green,  
2 and blue color component for each three-dimensional model.

1                   8. The method of claim 3, wherein step (d)(i) comprises computing polynomials  
2 from descriptions of the direction of the surface normal at each point and from the at least one  
3 corresponding identifier.

1                   9. The method of claim 1, wherein the linear subspace is four-dimensional.

1                   10. The method of claim 1, wherein the linear subspace is nine-dimensional.

1                   11. The method of claim 1, wherein step (e) comprises determining the  
2 magnitude of the difference between the input image and each rendered image.

1                   12. The method of claim 1, wherein step (d)(ii) comprises computing the point in  
2 the linear subspace that is closest to the input image using a linear projection.

1                   13. A method for choosing an image from a plurality of three-dimensional  
2 models which is most similar to an input image; the method comprising the steps of:  
3                   (a) providing a database of the plurality of three-dimensional models;  
4                   (b) providing an input image;

5 (c) positioning each three-dimensional model relative to the input image;  
6 (d) for each three-dimensional model, determining a rendered image that is most  
7 similar to the input image by:  
8 (i) computing a linear subspace that describes an approximation to the set  
9 of all possible rendered images that each three-dimensional model can produce under all possible  
10 lighting conditions where each point in the linear subspace represents a possible image; and  
11 (ii) finding a rendered image in a subset of the linear subspace obtained by  
12 projecting the set of images that are generated by positive lights onto the linear subspace;  
13 (e) computing a measure of similarity between the input image and each rendered  
14 image; and  
15 (f) selecting the three-dimensional model corresponding to the rendered image  
16 which is most similar to the input image.

1 14. The method of claim 13, wherein step (a) comprises building each three-  
2 dimensional model from a series of images taken under predetermined lighting conditions.

1 15. The method of claim 13, wherein step (a) comprises assigning a location to  
2 each point on the surface of each three-dimensional model and at least one corresponding  
3 identifier which identifies the fraction of light that is reflected at each point.

1 16. The method of claim 15, wherein the at least one corresponding identifier  
2 comprises three albedos, one for each of how much red, blue, and green light is reflected.

1 17. The method of claim 13, wherein step (b) comprises providing a two-  
2 dimensional input image.

1 18. The method of claim 13, wherein step (c) comprises aligning predetermined  
2 points on the three-dimensional models and the input image.

1 19. The method of claim 13, wherein step (d) is repeated for each of a red, green,  
2 and blue color component for each three-dimensional model.

1 20. The method of claim 15, wherein step (d)(i) comprises computing  
2 polynomials from descriptions of the direction of the surface normal at each point and from the  
3 at least one corresponding identifier.

1 21. The method of claim 13, wherein the linear subspace is four-dimensional.

1 22. The method of claim 13, wherein the linear subspace is nine-dimensional.

1 23. The method of claim 13, wherein step (e) comprises determining the  
2 magnitude of the difference between the input image and each rendered image.

1 24. The method of claim 21, wherein step (d)(ii) comprises rendering an image of  
2 each three-dimensional model using non-negative lighting by solving a sixth order polynomial.

1 25. The method of claim 22, wherein step (d)(ii) comprises finding the rendered  
2 image that is a convex combination of images generated with light coming from a single  
3 direction, projected onto the nine-dimensional space.

1 26. The method of claim 25, wherein the rendered image is found using a non-  
2 negative least squares algorithm.